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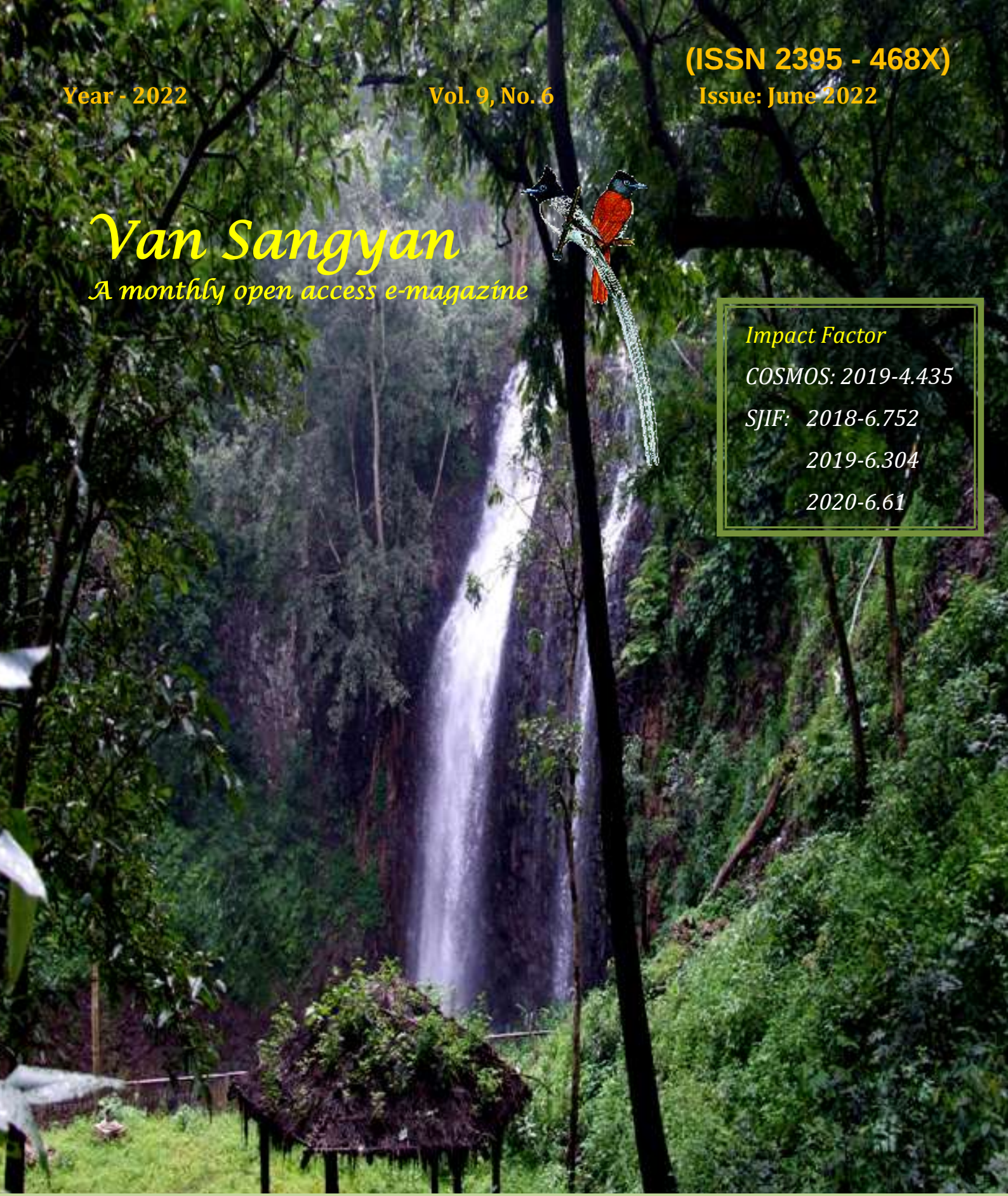

Van Sangyan

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Van Sangyan

Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

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or, through post to The Editor, Van Sangyan,
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The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number. TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve
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From the Editor's desk

Swietenia macrophylla has a wide natural distribution, extending from Mexico to Bolivia and central Brazil. However, large areas of former S. macrophylla forests have been converted to other uses, or the remaining forests are few. The depletion of S. macrophylla populations has lead to concern for the future of the species and its commercial trade.

Swietenia mahagoni is native to southern Florida and the islands of the Caribbean Sea. The wood has been internationally traded for over 400 years. Small-leaved mahogany was introduced in India from the West Indies in 1795, and since then has been planted throughout the tropics on a small scale in timber plantations and as an ornamental, occasionally also in tropical Africa. Attempts to introduce small-leaved mahogany to tropical African countries (e.g. Nigeria, Kenya, Uganda and Tanzania) were largely unsuccessful due to the severity of shoot borer attack on young plants. It has been planted more successfully in Réunion and Mauritius, and small-scale plantations exist in Egypt. It is occasionally planted in gardens, e.g. in Senegal and Mozambique.

Swietenia wood (mahogany) is regarded as the world's finest timber for high-class furniture and cabinet work. Its popularity is especially due to its attractive appearance in combination with ease of working, excellent finishing qualities and dimensional stability. It is also often used for interior trim such as panelling, doors and decorative borders. It is used for boat building, often as a decorative wood for luxury yachts and ocean liners, but sometimes also as plywood for planking and deck housing. Its outstanding technical qualities make it particularly suitable for precision woodwork such as models and patterns, instrument cases, clocks, printer's blocks and parts of musical instruments; for these purposes, uniform straight-grained material is used. Other minor uses include burial caskets, wood carvings, novelties, toys and turnery.

An oil can be extracted from the seed kernels which might be of some commercial value. The bark has been used for dyeing and tanning leather. Various medicinal uses of various parts of the tree are reported from tropical America. The crushed fruit shells have been used as a potting medium. Swietenia mahagoni is also used in reforestation programmes and as a shade tree in young plantations of other timber species, and is occasionally planted as an ornamental.S. mahagoni is a commonly used herb in Folklore medicine. The chemical entities of this plant have been proved for their Anti-bacterial activity, Antimicrobial Activity, Anti-oxidant activity, Antiulcer activity, Anti-fungal activity, Antiinflammatory, Analgesic activity, Hypoglcemic activity, Platelet Aggregation Inhibitors activity etc. These scientifically proved activities can be related with the traditional usage of the plant.

Thus S. mahagoni is one of the most important plants that has a tremendous scope for research in future. The novelty and applicability of this valuable species are hidden. Such things should be overcome through extensive scientific research. The drug may be a good candidate for developing a safe, tolerable, and promising neutraceutical treatment for the management of many diseases. Though the plant is widely used for the treatment of a large number of human ailments, being an endangered species, our prime motive is to conserve such valuable plant species from going extinct.

In line with the above this issue of Van Sangyan contains an article on Swietenia mahogany (L.) Jacq – an endangered timber yielding and medicinal tree species. There are also useful articles viz. Glossy fruits and vegetables -Winsome to the heart, contrary to the body, Agroforestry models of Hadoti region of Rajasthan state, Corymbia Citriodora- A multi -purpose tree species, Degradation of primary natural habitats and avian biodiversity loss, Sammi reddy technique of pulpwood yield estimation, Light trap: An eco-friendly tool of integrated pest management, Vanya silk: An exclusive non- timber forest produce and Larval parasitoids, Apanteles species as insect biocontrol agents.

I hope that readers would find maximum information in this issue relevant and valuable to the sustainable management of forests. Van Sangyan welcomes articles, views and queries on various such issues in the field of forest science.

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Swietenia mahogany (L.) Jacq – An endangered timber yielding and medicinal tree species

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Introduction

Over the past 3 decades, there has been a lot of effort oriented towards the assessment, and conservation status of Near Threatened (NT), Vulnerable (V), Endangered (EN), and Critically Endangered (CR) species. One such tree species under the Endangered (EN) category of the IUCN red list is *Swietenia mahogany*. The tree also falls in Appendix II of the lists provided by the CITES (Convention on International Trade in Endangered Species)**.** *S. mahogany*. L Jacq belonging to the family Meliaceae is an important medicinal tree of Tropical America commonly known as Mahogany. It is basically an evergreen tree and sometimes acts as a deciduous tree when grown in drought conditions. The tree is generally tall, with a heavy spherical crown and branches that cast dense shade. Hence, this tree is grown as an ornamental tree in various parts of India. It is a valuable timber tree closely related to the African genus Khaya, which is used for traditional medicinal uses.

Common names

Mahagni, West Indian Mahogany, Mahoni, Honduran Mahogany etc.

Phylogenetic classification

Division: Magnoliophyta; Class: Magnoliopsida; Order: Sapindales; Family: Meliaceae; Genus: Swietenia; Species: mahogany; scientific name: *Swietenia mahogany*

Global distribution

It is native to West Indies and Central America, Bahama, Cuba, Jamaica, Netherlands Antilles, and Haiti. It is exotic inSouth-East Asian countries like India, Bangladesh, Indonesia, Sri Lanka, the Philippines, etc. In Indian subcontinent it is found almost in all regions but most prominently in Kerala, Andhra Pradesh, Maharashtra, Odisha, and Tamil Nadu

Botanical description/ Morphology

It is a tall tree that can grow up to 30 meters high, with a short bole and buttressing base. The bark is smooth grey on young trees and turns to scaly dark reddish-brown on mature trees.

Foliage

Compound leaves those are pinnate consisting of 8-12 pairs of leaflets. Each leaflet is leathery, ovate to lanceolate with an entire or serrated leaf margin. Leaflet also has an acuminate apex and a short petiole.

The color of the leaf is dark green on the lower surface, while it is light green on the upper surface.

Bark

Dark grey, rough, and scaly, flakes off to reveal red patches with maturity.

Flowers

Greenish-yellow flowers with five petals, five sepals, a cylindrical staminal tube, and

ten stamens. Ovary 5 - locule with narrow style. Even when all the flowers are pollinated, only one blossom usually develops into the fruit and the remaining is aborted.

Panicles are glabrous and shorter than leaves. Both male and female flowers exist on the same plant.

Fruit

Mature fruit is a large woody brown capsule that explodes into 5 equal sections from the base upwardsand discharges numerous brown long-winged seeds. The seeds are often regarded as "Sky fruit". A good number of fruits can be obtained from age of 20-40 years.

Seed

Winged type of seeds are present (Samaras), 5-6 cm long, when matured turn into reddish-brown color. In the natural, seeds are disseminated through the wind.

Seed storage

The seeds have short viability, and most of them lose their viability at 3 months and by the end of 6 months, they completely lose their viability. When the seeds are air-dried and sealed in airtight containers, they remain viable for up to 6 months. Viability can be increased to 1 year when they are stored in hermetic air-dry storage at room temperature.

Phenology

Flowering

Occurs in spring mostly March-April. The new leaves are reddish-purple and turn yellow-green.

Fruiting

Fruiting occurs from summer to winter. Both flowering and fruiting are regular, and annual and take place just before the rainy season. The trees fruit well and start seeding at the age of 20 years and sometimes it doesn't seed until the age of 30-40 years old depending on the site characteristics.

Ecology

It requires a warm climate with temperatures ranging from 16-32^{0}C with a mean annual rainfall of 800-2500 mm. The best soils suitable for easy propagation are well-drained sandy soils, and it is a massive failure in drought areas and poor soils and avoids stiff and heavy soils in the wild. This tree can be found at an altitude of 50-1500 m. The preferable pH is 6-7, but it can tolerate 5.5-8.

Propagation techniques

It is mostly propagated through seeds. Seeds have short viability and need to be sown as soon as they are ripe.

Nursery technique

Seeds should be broken and sown in a nursery bed containing well-drained soil. The seedbed should be covered by partial shade. Germination starts after 15 days of sowing up to 30 days. When the seedlings are 3-4 weeks old, overhead shade is removed and allowed for full sunlight or lateral shade is also preferable.

After a month or when the second sprout of seedling has started, they are ready for transplanting.The seedlings of mahogany require light, in the absence of overhead light; the seedlings are susceptible to insect attacks. Cuttings from 3-year-old plants are usually best for this method and do not show better growth when taken from old and mature trees.

Uses

The tree is rich in phenolic compounds including different terpenoids, and limonoids. The timber has commercial value in the trade due to its high resistance to decay and insect attack. The wood is exceptionally smooth and has a lustrous

surface; therefore, it is the best choice for high-quality furniture, cabinet works, joinery, boats, and pattern work. In past, timber is majorly used for the construction of warships in Spain. Due to its superior tone quality, it is used in making modern musical instruments.

Most of the branched woods and crooked stems are converted to charcoal and used as fuel components. The bark is antiseptic and astringent. It is taken orally as a decoction to treat diarrhoea and dysentery. The decoction is externally used to treat wounds by firearms. Oil can be extracted from the kernels of the seed which might be of some commercial value. The bark can also be used for dyeing. Seeds are used as a folk medicine for the treatment of hypertension, diabetes, and malaria. In addition, they have therapeutic value for the treatment of cancer, amoebiasis, coughs, and chest pains. Ether extracts of seeds inhibited platelet aggregation.

In Agro-forestry

Generally, these are placed along the boundaries of courtyards or farms where they cast deep shade. Due to its heavy branching and crown, it is used as a shade tree in coffee, and cocoa plantations. This tree is majorly used in reforestation projects and as a shade tree in young plantations of other timber-yielding plantations.

Pests and diseases of Indian mahogany

There are various pests and diseases associated with this tree but are region-specific. Mahogany webworm causes defoliation, and webbing throughout the Greater Antilles, in Asia, *Hypsipyla robusta* attacks the tree, and the coffee tree borer attacks young, mature, and dead trees also and makes them susceptible to wind damage by deep penetration into branches and deforming trunks. The seed capsules are attacked by the beetles in Haiti. Some insects can cause significant problems such as tent caterpillars, tip moths, leaf notchers, and leaf miners. Heart and butt rots are common in older trees, apparently entering through basal scars, and branch stubs. Some common diseases of mahogany are leaf spot, anthracnose, leaf blister, damping off, and stem blight.

Flowers

Leaves

Matured fruit ready for dispersal

Inflorescence of Mahogany

Leaf damaged by Cuban leaf beetle

Mahogany Webworm larvae

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Glossy fruits and vegetables -Winsome to the heart, contrary to the body

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Abstract

The ever-increasing demand of the healthy fruits and vegetables is starkly visible in the era of modernization, where we have labelled shining and lustrous property of a commodity a criterion of its freshness. The ignorance of modern peoples to visualize shine a mark of purity is motivating more use of chemicals in the fruits and vegetables. In the recent past, the incidence of chemical application on fruits and vegetables is increasing frequently. The alluring shine and luster of fruits and veggies is commanding us to buy them in ignorance of cost on our health. The effect of these glossy fruits and veggies is stark on our body in the long run. This article mainly focuses on the toxic chemicals used in the present world to make fruits and vegetable presentable along with to increase the shelf life. The article also addresses the implications of the chemicals on our health along with the solution to avoid serious repercussions of the chemicals on mankind in the long run.

Key Words

Coatings, Morpholine, Luster.

Introduction

The Aeon of modernization and commercialization is a pleasing weapon to kill the human regime. The fascinating techniques of robotic farming systems, hi-tech agriculture, and food production have led humans to enjoy life with much ease and less effort. But the question arises, till when? Is the human era immortal or resistant towards facing the reverberations of their endless and ruthless deeds? The world is on verge of bad health as compared to before. Fruits and vegetables are the gift to humanity from nature, but we humans and our unceasing greed has deteriorated nature's gift in order to satisfy our demands. The lusty and shiny veggies and fruits we look are appealing and attractive, although possessing layers or coatings that cause severe harm to humanity. As these are good on terms of weight loss but possesses carcinogenic substances that are no doubt harmful to humans. Thus, as a result, this article provides a comprehensive perspective on the interference of human-proposed technologies in the processing of fruits and vegetables. Fruits and vegetables are regarded as the best edibles to lead a fruitful life, with 80-90 per cent of water by weight. These highly perishable products when left with open cuticle tends to decrease in quality due to immense gaseous exchange and high respiration rate. The main degradation in quality of fruits and vegetables is seen between harvesting to transporting. An epidemiological study revealed that human body can benefit from consumption of five servings (400 mgs. in total) of fruits and vegetables per day, which potentially

decreases the vulnerability to chronic non-communicable diseases, like colon cancer, stroke, and arteriosclerosis. The coatings were applied initially on oranges and lemon which are considered as the first fruits to be coated with wax. Fruits and vegetables are in high demand due to their anti-microbial, anti-inflammatory, and anti-oxidant properties. Humans and animals depend on fruits for their major life functioning, which is seen to create a huge pressure on countries to produce fruits and vegetables with long shelf-life. According to food production report 2018, the fruit production has increased to 3.2 per cent from 2012-2013 which shows a positive increase from 2013-2020 (FAOSTAT, 2018). With this increase in demand, there arises need for technologies and methods so that they can be kept for long time without impairing their texture and quality. There are several coating methods developed during recent periods in order to retain fruits and vegetables for longer time and maintain their luster. Out of these, a couple of treatments presuppose coating techniques which have chemicals in them. These chemicals possess harmful effects on human body when consumed. Coating fruits and vegetables with morpholine, nano-particles and other hydrocarbon compounds create huge problem on human health, and is a serious issue under concern.

Definition

A coating is a protective covering that is placed to a surface to shield it from harmful effects. Coatings are commonly applied on fruits and vegetables to keep them fresh for a long period. Fruits and vegetables typically contain 80-90 per cent water, which degrades between harvesting and transportation. Coatings are generally of animal or plant-based. Depending on the situation, polysaccharide, lipid, protein, or resin can be used alone or in combination for coating (Shami Sardar Vallabhbhai Patel et al., n.d.). Coating of fruits and vegetables is a common method that dates back to the early twentieth century. The persuasion of method was to keep them natural for spun-out. These coatings operate as barriers, extending the shelf life and lowering the rate of respiration succeeding harvest. Coating tends to be fairly particular in their approach by directly interfering with chemical processes in fruits and vegetables. They give the product a shiny look along with acting as a thin, waxy surround. The increased demand for fruits and vegetables along with their distant transportation, demands for techniques which can keep them fresh for longer interval. Due to subject of quality degradation succeeding low shelf life and perishable nature, coating them with chemicals and hard substance is necessary for their long preservation. The coatings were applied initially on lemon and oranges, which are considered as the first fruits to be coated with wax. The recent study made by Lin et al., (2017) shows the effect of coating on various fruits and vegetables along with the involvement of excessive fertilizers during plantation time to increase the yield as a good effort for keeping them fresh and increase their economy but has negative effect on human health. In the early years fruits and vegetables were coated with wax and edible coatings that barely had adverse effect on humans, but with the invention of recent techniques and modification the edible coatings have been replaced with toxic chemicals and U.V plus coating.

Apart from increase in the modernization, the choice of high processed fruits and vegetables which can be stored for longer time are in demand, is posing severe effect on food industries. The recent demand from public for fresh and lustrous fruits and veggies has led to the use of chemical and toxic substance which provides rapid results by reducing the respiration rate and dullness. The lustrous shiny coats on them are evidence of human intervention with the nature.

History

The history of coating dates back to 12 th - 13 th century when Chinese for the first time used wax coating on oranges and lemon in order to preserve them. Though they were not aware of the exact benefits of coating still they made an assumption of how coated fruits and veggies can be preserved for longer time. Later in 1930's fruits and veggies coated with hot-melted wax was introduced for the first time; another technique during the same year called larding was in vogue in England which is generally the fat coatings. Lowings and Cutts discovered an edible covering material that is non-phytotoxic, tasteless, and odorless, and can extend the shelf life of fruits and vegetables. Sucrose fatty acid esters (SFAE), sodium carboxymethyl cellulose, and mono- and di-glycerides make up this coating material. SFAE was first created as an emulsifier and later on with passing year several coatings including wax, honey, lipids, were introduced.

Action

Fruits and vegetables can be coated with wax, esters, or polysaccharides to extend their shelf life by lowering their respiration rate, which prevents excessive water loss. They are kept firm, fresh, and viable for longer time (McHugh and Senesi, 2000). They act as a barrier in gaseous exchange between the layers of fruits and give them shiny and lustrous appearance.

Properties

- Edible coatings depend highly on their molecular structure rather than molecular size, and they are seen to show following properties according to (Arvanitoyannis & Gorris, 1999).
- Edible coatings contain active ingredients such as anti-oxidants, vitamins and other chemicals that improve the nutritive value of fruits and vegetables without compromising their freshness.
- It shouldn't deplete oxygen or produce too much carbon dioxide.
- It should improve appearance, maintain structural integrity, improve mechanical handling properties, carry active agents (anti-oxidants, vitamins etc.) and retain volatile flavor compounds.
- It should have a minimum of 1–3 percent oxygen around it to avoid a shift from aerobic to anaerobic respiration.
- It must have a low viscosity and be cost effective.

Composition

Coatings are composed of highly complex hydrocarbons which include polysaccharides, proteins, lipids, and composites edible coatings are mainly divided into three classes.

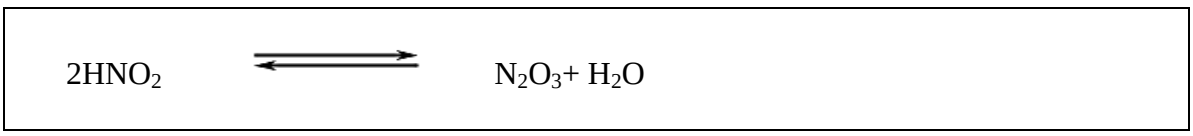
1. Hydrocolloids: e.g., polysaccharides, proteins and alginate.
2. Lipids: e.g., fatty acids, acryl glycerides and waxes.

3. Composites: e.g., protein/protein, polysaccharides/protein, lipid/ polysaccha-rides.

Apart from these, other chemicals included in coatings are: calcium carbide, ethephon, and oxytocin. The food commodities are reported to be contaminated with these toxic and health hazardous substances.

Toxic coatings: The new trend

The art of coating fruits and vegetables is quite old. These glossy appearances of fruits and veggies have severe effects engulfed within them. The coating was a way to increase the shelf life as the major losses in fruits and vegetables were noticed during handling, storage, and transport. The art of coating fruits and vegetables is quite old. With the invention of recent techniques, the edible coatings have been replaced with toxic chemicals, U.V plus coating and nano-sized metal particles, high-carcinogenic layers, which seem to work with double efficiency by delaying the maturity period, respiration rate and reducing weight, which is made possible by reducing the water content in order to keep fruits and veggies fresh for longer duration. The toxicity of edible coatings containing nano-sized metal particles should be examined extensively since it possesses the potential to induce allergic reactions, especially in freshly cut products due to the release and migration of metal ions. The onset of the Green Revolution in the period of 1960's was viewed as a very revolutionary phase for the farming sector. Chemicals, fertilizers and hybrids were introduced to the field, proving that the production was sound and desirable. However, in light of the repercussions, the outcome was less lucrative. Fruits and vegetables are essential for human health and well-being. The safety of human health is jeopardized by these initial hazardous substances. The use of artificial sweeteners to change the taste of fruits and vegetables, as well as a variety of other unpleasant alterations in their nutritional makeup, is a clear indicator of human activity against mankind. Sen and Badoo (1989) reported one such incident where fruit and vegetable sample were tested to inspect out the morpholine content. Morpholine which is a toxic substance with permissible upper limit of 20 ppm itself don't produce toxicity, but during digestion in the alimentary canal it under goes nitrosation and forms N- Nitroso morpholine (NMOR) which is seen to be a major cause of cancer (Fig1). The evaluation made by Sen and Badoo showed the results of high morpholine content in oranges with 0.3mg/kg equivalent to tobacco with 4.0mg/kg, which shows equal chance of cancer for both smokers and non-smokers. Fruits are loaded with preservatives, waxes and saccharine sweeteners in order to increase their shelf life and make them look them in good shape. But application of waxes alone cannot keep fruits and vegetables fresh and decay free, thus in such they are mixed with morpholine content to keep them safe and fresh.



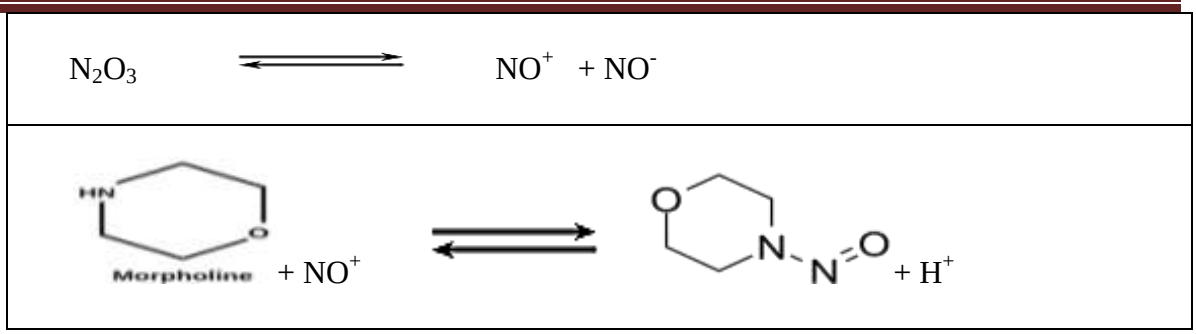


Figure 1: Nitrosation of Morpholine to form NMOR

Making veggies appealing and compelling, according to nutritional therapist Meenakshi Bajaj, is not recommended for most individuals, especially pregnant and lactating women. India has a diverse economy and is home to about 190 million under nourished people, accounting for a quarter of the world's hungry population. India was ranked 101 out of 116 nations despite various initiatives to alleviate and cure poverty (Global Hunger Index 2021). A recent report by the Food Safety and Standard Authority of India (FSSAI) that fruits and vegetables contain highly harmful and felonious pesticides above the permissible level brought the dangerous and terrible situation to light. Brinjal, cabbage, cauliflower, and other vegetables are believed to be intoxicated with prohibited pesticides in excess of a legal level. Pesticides used in management of pest and diseases in agriculture and horticulture crops. Heavy metals are present in irrigation water and soil acts as the source of fungal toxins. They leave adverse effects on the nervous system. Some harmful pesticides cause hazardous disease like cancer, liver, kidney related issues. The pesticide residue found in fruits and vegetables include residues of both banned (Aldrin, Chlordane) and restricted pesticide (Endosulfan).

Objective

Coatings of fruits and vegetables are crucial in today's world. They produce a glossy coating and decrease gas exchange, extending the shelf life of the product. However, the coating composition is changing all the time, and it is being combined with dangerous substances that increase the shelf life, although having adverse effects on humans' health. The major goal of this study is to bring into light the dangerous substances that are hidden beneath the glossy and bright surface.

Methodology

What are wax coatings in fruits and vegetables?

Wax coatings, also known as edible coatings, are soluble compositions that create a layer over fruits and vegetables to give them a shiny appearance while also preventing the passage of gases and moisture. Proteins, polysaccharides (carbohydrates and gums), lipids, or a combination of these, make up these sheet-forming biopolymers. Because of their covalent composition and strong disulfide bonds with significant ionic contact, biopolymers have an inherent film-forming capability. Several years later, wax coating of fruits and vegetables with these coatings became an art form. The coatings were seen as a substitute for

protecting fruits and vegetables against speedy decay.

Is it safe to eat waxed fruits and vegetables?

The flavor and look of glossy fruits and vegetables are appealing, but their consequences on humans are disastrous. According to recent research, the glossy coating of fruits and vegetables dipped in petroleum oil, fats, and copper sulphate solutions is not safer than prior coatings of bee wax, candelilla wax, and carnauba wax, which contain ester bonds rather than petroleum wax's alkane link. Because they include copper sulphate, which is insoluble in water and damages the liver and kidneys, these substances are extremely harmful to one's health. Petroleum oil and fats dipped in fruits are not only carcinogenic to the body, but also have a negative impact on the nervous system. These practices are in accordance with the coatings trend for early ripening and appealing appearance of vegetables such as tomatoes and brinjals, as well as a few fruits such as mangoes and bananas. These gleaming layers are primarily carbide coatings that cannot be removed with water alone. These chemicals, which are often applied in fruits and vegetables these days, represent a major concern because when they come into touch with the human body creates very harmful radicals. Morpholine was included in EPA (Environment Protection Agencies, US) master list for toxic substances control act in 1996.

Methods of application

a) Dipping, b) Brushing, c) Extrusion, d) Spraying and e) Solvent casting.

For application of edible coatings to fruits and vegetables, the dipping method is extensively employed, which includes dipping fruits and vegetables in a coating solution for 5–30 seconds. Fruits and vegetables are dipped immediately into the solution and to let dry in this procedure. The coating thickness is defined not only by its viscosity and density, but also by the length of time the product is dipped in it. It's simple to use on most fruits. Edible coatings are typically applied to beans and highly perishable fruits and vegetables such as strawberries and berries, despite the fact that brushing provides reasonable results. Larger regions of fruits and vegetables may be covered under this strategy. Spraying techniques may also be used to apply different coatings in the form of aqueous or suspensions, which aids in the formation of hydrophilic and hydrophobic coatings. In the edibles business, extrusion and solvent casting are also employed. Extrusion coating is the process of covering a substrate material with a molten web of synthetic resin. Extrusion is the ideal approach for applying emulsifiable concentrates for industrial uses when compared to other techniques since it relies on the thermoplastic qualities of edible coatings (Valverde *et al*., 2005). (García-Valverde & Torroba, 2005)

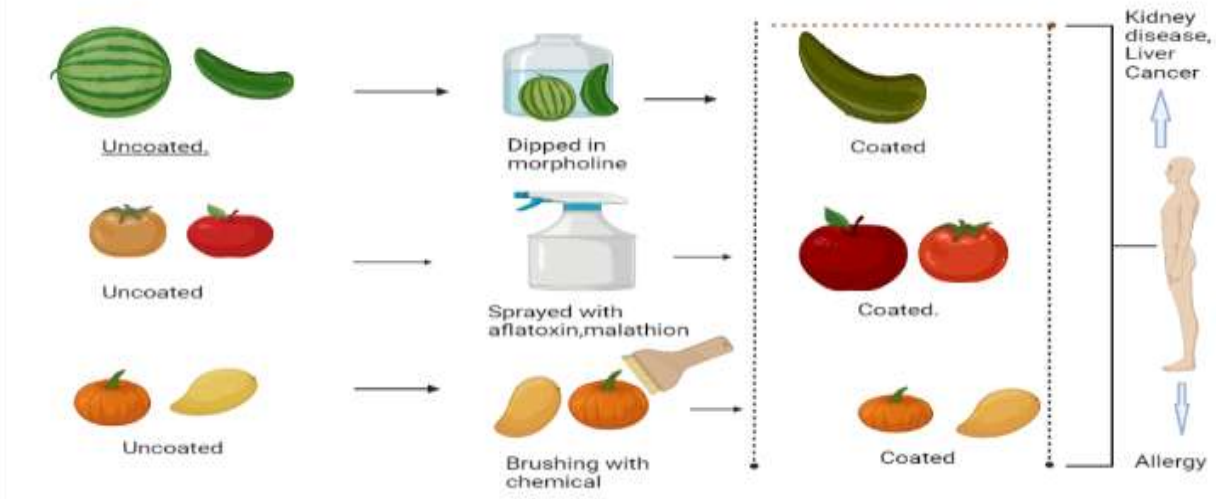


Fig 2: Methods of toxic coating on fruits and vegetables along with their effect on human body.

Fruits and vegetables to be coated

Discussion

Coating of fruits and vegetables are usually done to make their covering more lustrous and give them an alluring appearance. People who consume fruits and veggies daily clearly know the difference between fruit off the branch and fruit off the table. A freshly picked apple is less shiny with uneven smoothness, but the introduction of coatings has led humans to provide high lustrous quality to fruits and veggies. The apples kept on supermarket area are generally attractive and shiny enough to the experiment conducted by various authors revealed how coatings can increase shelf-life of fruits and vegetables and keep them fresh for longer duration which is quite beneficial but at times coatings of fruits and veggies is seen to engulf harmful substances which are detrimental to one's health and possess severe health problems. Sahoo et al. (2017) investigated the influence of coatings on fruits and vegetables, which decreased microbial contamination by regulating gases and moisture while still maintaining flavor and scent. In comparison to the control, fruits and vegetables had a longer shelf life. Raghav et al., (2019) conducted an experiment to find the numerous issues and advantages associated with fruit and vegetable coverings in depth. The findings revealed that fruits and vegetables had a high level of post-harvest durability. According to the survey, fruits and vegetables were also in high demand owing to their glossy and shiny looks. In the same way, Khorram et al. (2017) (Khorram et al., 2017) investigated the effects of edible gelatin coatings (5, 6), On Valencia oranges (which are termed hesperidium, a type of transformed berry after storage), Persian gum (3.5, 4, and 4.5%) and 9, 10, and 11% shellac were applied. The edible samples' composition was determined by the qualities of the chosen components, which are easy to dissolve and affordable. The coated oranges were then kept refrigerated for 60 days at 5 degrees Celsius. Every 20 days, samples were evaluated, and pictures of the coated surfaces were taken using scanning electron microscopy. As the storage period was prolonged, the titratable acidity and acid content declined,

while the pH, total phenolic content, and total antioxidant capacity values rose. A glossiness effect was noticed in all coated samples. Fruit coated with gelatin and Persian gum coatings, on the other hand, developed noticeable fissures as storage time increased. Shellac was the ideal edible coating option since it generated a non-sticky, odorless coating with a high glossy appearance during the full storage duration. (Avramescu et al., 2020) Avramescu *et al.* (2020) conducted a recent study to see how fruit and vegetable coatings aid to avoid rotting and have favorable results in the food business. Fan et al. (Fan et al., 2021) Click here to enter text.2019) looked at how lotus leaf extract (LLE) mix coatings affected the quality of fresh goji berries kept at room temperature after harvest. With 0.2 percent LLE, 1 percent basic coating (sodium alginate, konjae glucomannan, and starch in a 2:3:3 ratio), 1 percent glycerin, and 0.5 percent $CaCl_2$, the greatest results were obtained. The findings show that LLE-incorporated coatings extend the shelf life of goji berries by around four days and improve quality preservation. Edible coatings and films made from natural hydrocolloids give further protection for fresh or blanched fruits and vegetables. According to Salehi 2020, (Salehi, 2020) natural gum edible coatings provide a viable technique to increase the quality and shelf life of fruits and veggies and keep them disease and fungus free.

Fruits and veggies	Coating used	Another compound	Benefits	References
Apple	Gallen gum	Sunflower oil	Reduction in ethylene production, microbial deterioration, ant browning.	Rojas and Garu *et al.* 2008(Montero-Calderón et al., 2008)
Apricot	Methylcellulose	Stearic Acid	Reduces Vitamin C and water loss during storage, improves fruit quality.	Ayranci and Tunc (2004) (Ayranci & Tunc, 2004)
Avocado	Pectin	Bee's wax	Reduction in disease spread, fruit softening.	Maftoonazad *et al.* 2007(MAFTOONAZAD et al., 2007)
Tomato	Arabic gum	Glycerol	Improves post-harvest quality	Ali et al 2013. (Ali et al., 2013)

Table: Showing gum coating on fruits and veggies and their benefit.

The above table shows the positive effect of coating materials along with their role in maintaining fruits and veggies fresh for long period.

Harmful Effects of Toxic coatings in Human body

Cancer

Morpholine is a solvent and emulsifier extensively used in the production of wax coverings for fruits and vegetables.

Morpholine does not pose a health concern when consumed in the amounts found in fruits and vegetables (Fig 2), but when it comes into touch with nitrate inside the body, however, it creates Nitroso morpholine (NMOR), a genotoxic carcinogen that can cause kidney or liver cancer or Kidney failure.

Risk of liver and kidney damage

Experts report that an oral and intravenous administration or after inhalation, morpholine is well absorbed and distributed in the body fluids. Ingestion of morpholine through daily consumption of wax-coated fruits can affect kidney and liver functions badly.

Allergies

Many coatings include cold substances that cause throat problems along with toxicity to our body. To avoid the same before eating, wash the fruits and vegetables properly. Washing fruits and vegetables with care and thoroughness is the simplest method to consume them without chemicals. Washing also aids in the removal of debris that has been stockpiled on the surface layer.

Advice to consumers

- Hand-pick fruits and vegetables those are free of spots, necrosis (lesions), and any other abnormalities.
- Before eating or cooking, thoroughly wash fruits and vegetables with water (ideally running potable water).
- Fruits and vegetables should be purchased from reputable vendors.
- Pesticide exposure can be reduced by peeling fruits and vegetables before eating or preparing them.
- Avoid buying and eating sliced fruits from the open market.
- Throw away moldy or fungus-infected fruits and vegetables

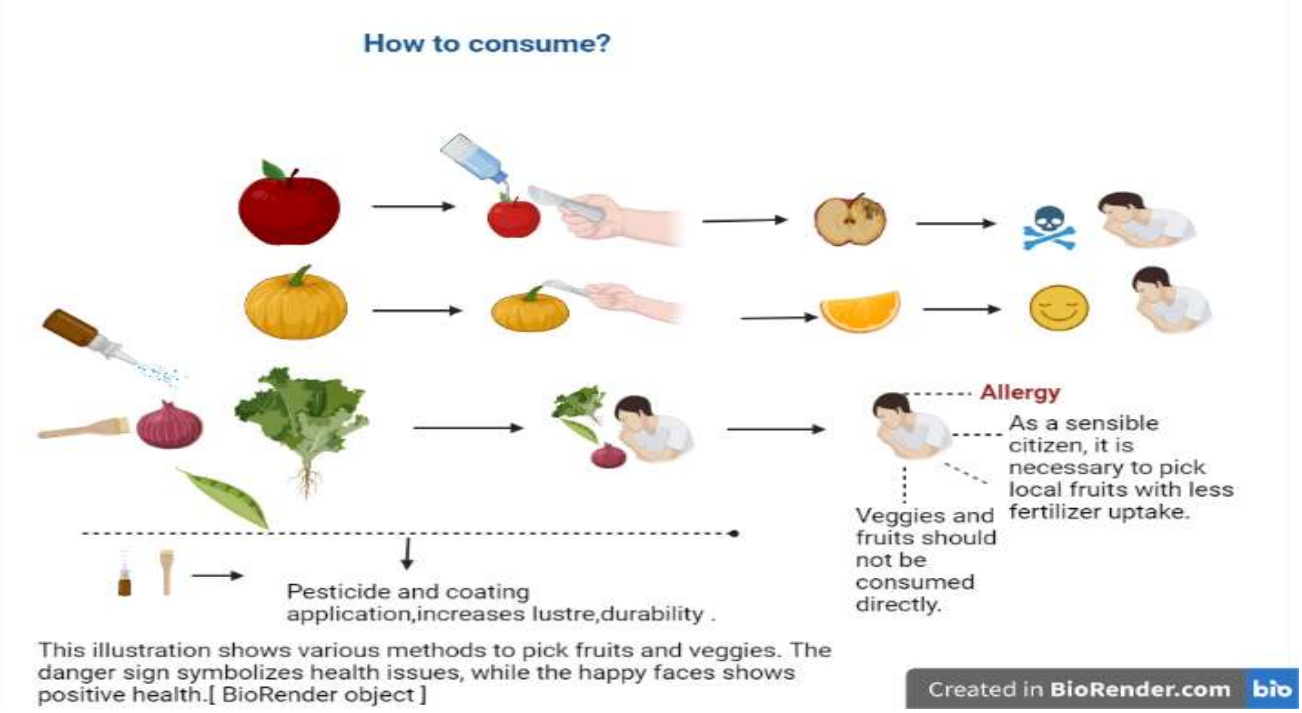


Fig 3: Tips for customers before purchasing fruits and Veggies

Solutions

Don't get misled by the attractive mirage of fruits and vegetables. Fruits and vegetables with glossy coats contain a higher concentration of chemicals. The gleaming effect is said to be caused by a very poisonous chemical that is harmful to the human body. Make an effort to eat fruits and vegetables grown in your area. Local fruits and vegetables are grown with regular attention and less fertilizers and pesticides. In addition, wax coats are more common on off-season fruits. Foods with natural coatings, such as aloe-gel and chitosan, contain minimal or no sugar, having less or no amine composition. Pulling out of the outer leaves of leafy vegetables such as lettuce and cabbage can reduce the risk of chemical residues. Detergents should not be used to wash fruits and vegetables since they might be absorbed. Use clean utensils and a clean cutting board with stainless steel knives after washing your hands with soap and water for chopping and cooking. A new generation of edible coatings is under development, which aims to incorporate and/or control release of active compounds using nano-technological solutions such as nano-encapsulation and multilayered systems. Nowadays, nanotechnologies are being used to enhance the nutritional aspects of food by means of nano-scale additives, nutrients and nanosized delivery systems for bioactive compounds (Kumar, 2016). Micro and nano-encapsulation of active compounds with edible coatings may help to control their release under specific conditions (Lopez-Rubio et al., 2006). Thus, protecting them from moisture, heat or other extreme conditions and enhancing their stability and viability, but these coatings have proved harmful to human body and are seen to be highly detrimental as the same time.

Conclusion and future trend

Fruits and veggies are in high demand due to their anti-microbial, anti-inflammatory, and anti-oxidant properties. They are generally perishable in nature with low shelf life. Because of this, to manage and store them is an essential step after their harvesting. But with the introduction of new technologies and the application of chemicals during the processing, has made mankind vulnerable to rare diseases. The question here arises that are we doing justice with our health by preferring these coated lustrous fruits and vegetables? The coatings provided for these fruits and vegetables are highly detrimental and toxic to our body. Though it has succeeded in increasing shelf-life of products but their interaction with human body is not for positive go. Thus, considering one a blameworthy human being, oneself needs to be highly defined while choosing fruits and vegetables. As one should prefer those fruits and vegetables which are available locally and without toxic coatings and lustrous appearance over the name of freshness.

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Agroforestry models of Hadoti region of Rajasthan state

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Abstract

Agroforestry is a promising land use practice to maintain or increase agricultural productivity while preserving or improving soil fertility. This paper is based on survey shows that most of the farmers of Hadoti region are growing mainly Horti-silvicultural (HS), Agri-silvi-horticultural (ASH), Agri-silvicultural (AS), Agri-horticultural (AH), Home-garden (HG), Horti-pastural (HP), Silvi-pastural (SP) and Apiculture (AP) at their field. Farmers of this region are adopting Agri-silvicultural (AS) system as teak, neem, babul as a boundary plantation with mustard, coriander and wheat crops mainly. Secondly, farmers adopting Agri-horticultural (AH) system in which farmers raise mandarin, lemon, guava with different types of agricultural crops. These exiting agroforestry systems provide more return per unit area as compared to mono cropping. These types of agroforestry systems are most important for fulfil of basic needs of farmers and for improving the microclimate of this region.

Keywords

Agroforestry systems, Farmers, Hadoti region, Micro climate, Production etc.

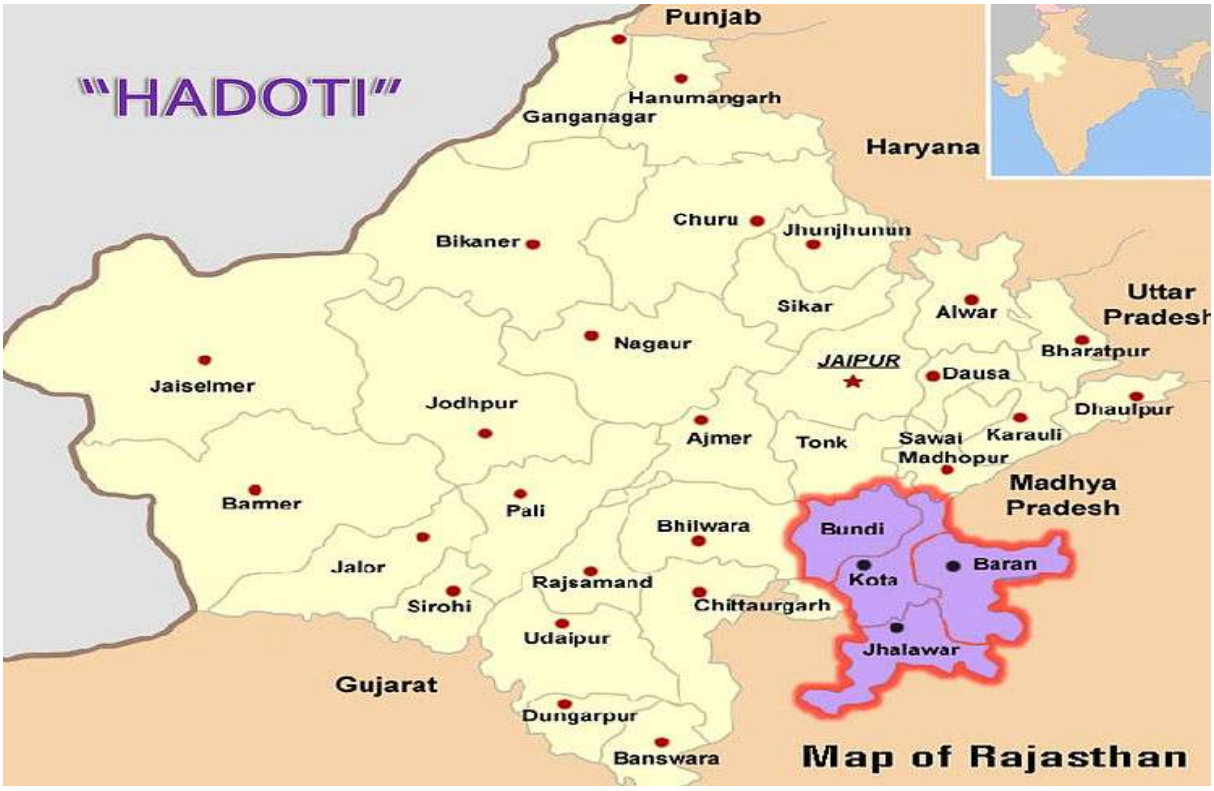
Introduction

Agroforestry practices come in many forms but fall into two group's *viz.*, first, is those that are sequential such as fallows and second, those are simultaneous such as alley-cropping. Among all, some 18 different agroforestry practices have some infinite number of variations to each other (Nair, 1987). Agroforestry is generally practiced with the intention of developing a more efficient and sustainable form of land use that can improve farm productivity and the welfare of the rural community. The total area under Agroforestry in the world is 1023 mha. Maximum areas of Agroforestry in the world are found in South America (3.2 million square kilometre) followed by sub Saharan Africa that is 1.9 million square kilometre (Kumar *et al*., 2014). However the area under Agroforestry is increasing continuously. In India, in 2007 it was reported 7.4 million hectare8 but in 2013 it reached up to 25.32 million hectare (Dhyani *et al*., 2013). At present in India, agroforestry is practiced between 17.45 m ha to 25.32 m ha. The estimated area under the agroforestry in Uttar Pradesh (1.86 m ha), Maharashtra (1.61 m ha) and Rajasthan (1.55 m ha) as first, second and third, respectively. However, there are still many challenges that impede the growth of agroforestry in India. These include a lack of uniform policies and regulations relating to felling and transporting farm-grown plant products like timber (Asharam *et al*., 2018). In the era of changing climate every country is looking for ensuring the food security of its citizen. In this context, agroforestry emerges to be the integrated and sustainable model of food production

catering to environmental services while assuring sustainable production as well. Judicious integration of tree species with agricultural crops and/or animals is the way to achieve the targeted 4 per cent sustained growth in agriculture by optimizing the farm productivity and enhancing livelihood opportunities of small farmers, landless and in particular women. Agroforestry systems significantly contribute towards livelihood improvement through 5Fs, i.e. food, fodder, fuel, fibre and fertilizer. Trees on farm can also help in generating diversified off-farm employment opportunities by supporting large number of wood based industries. Despite these magnificent contributions, the adoption level of agroforestry practices among the farmers is still limited. This calls for organized efforts in setting priorities and strategies for upliftment of rural livelihood through agroforestry research and extension services in India. The tree component of agroforestry systems can greatly contribute to the restoration of shattered domestic rural economies, becoming a prized capital asset for resource-poor farmers, compensating for seasonal shortages, providing recurrent flows of food, fuel, fodder and other useful materials for rural industries, and conserving soil, water and human energy (Kumar *et al*., 2014).

Study area

Hadoti is a region of Rajasthan state in Western India. The study area involves Hadoti region which comprises of Kota, Bundi, Baran and Jhalawar districts.



Methodology

The present study was conducted in the all four district of Hadoti region of Rajasthan. Information related to existing agroforestry models were collected through the farmers during the field visit at their agricultural farms. Total 32 villages were selected, 8 villages from each district, to conduct this filed study to fulfil the objectives of the present study.

Result and discussion

The present study revealed that farmers of different villages of Hadoti region of Rajasthan having different economical status have adopted peripheral and mixed planting almost to the same extent, with the number of marginal farmers being the same as the number of large farmers. Mostly farmers have prominently adopted eight types of agroforestry systems *viz*., Horti-silvicultural (HS), Agri-silvi-horticultural (ASH), Agri-silvicultural (AS), Agri-horticultural (ASH), Home gardens (HG), Horti-pastural (HP), Silvi-pastural (SP) and Apiculture (AP) according to their needs to achieve livelihood security. Similar results were found by Singh *et al*., 2017 and reported that the farmers of Navsari prominently adopted five types of agroforestry systems *viz.*, Agri-silvi-horticulture, Agri-silviculture, Agri-horticulture, Homegardens and Horti-pasture according to their needs to achieve livelihood security. Both types of agroforestry are popular all over the villages of the selected district. The farmers of Kota district are mainly growing guava orchard having eucalyptus, ardu, moringa and neem as a boundary plantation with different types of horticultural (guava, lemon, jamun) and agricultural crops (wheat, soybean, linseed, mustard and coriander). In Bundi, eight out of ten farmers raise eucalyptus, ardu and guava along with agricultural crops mainly paddy, coriander, linseed and wheat. The farmers of Baran district raise babul, mahua and palash as a boundary plantation or in combination with horticultural (jamun and lemon) and agricultural crops (gram, sugarcane, garlic and soybean). Similar results were recorded by Verma (1990) in a study in which nine out of ten farmers raise eucalyptus either in pure or in combination with other tree species.In Jhalawar district mostly farmer's raise teak, ardu, siris and mahua as a boundary plantation, mandarin and lemon as a main crops and garlic, mustard, gram and coriander as an intercrops. The table shows that neem (*Azadirachta indica*), teak (*Tectona grandis*), ardu (*Ailanthus excelsa*) and babul (*Acacia nilotica*) are the dominant tree species which were regularly found on agricultural field of this region during study. The major fruit crops of Hadoti region are lemon (*Citrus limon*), jamun (*Syzygium cumini*), guava (*Psidium guajava*) and mango (*Mangifera indica*). The important agricultural crops in this region are mustard (*Brassica juncea*), coriander (*Corinadrum sativum*), gram (*Cicer arietinum*) wheat (*Triticum aestivum*) and soybean (*Glycine max*). Chilli (*Capsicum frutescens*), tomato (*Solanum lycopersicum*), pea (*Pisum sativum*), okra (*Abelmoschus esculentus*), brinjal (*Solanum melongena*) and onion (*Allium cepa*) has been raised as a home garden. The apiculture system was also found in this region during the study association with palash (*Butea monosperma*), gulmohar (*Delonix regia*), mustard (*Brassica juncea*) and coriander (*Coriandrum sativum*) near water bodies in all districts.

Sr. No.	Agroforestry system	Tree component	Horti./Agri. crops
1	Horti-silvicultural (HS)	Neem, teak, babul	Guava, lemon, jamun
2	Agri-silvi-horticultural (ASH)	Eucalyptus, teak, mahua, neem	Mandarin, amla, jamun, coriander, mustard, wheat, soybean
3	Agri-silvicultural (AS)	Ardu, teak, neem, babul	Guava, jamun, lemon, paddy, coriander, mustard, soybean
4	Agri-horticultural (AH)	----	Mango, guava jamun, lemon, linseed, wheat, gram, soybean
5	Home-garden (HG)	Teak, neem, moringa	Guava, jamun, chilli, tomato, okra, brinjal, onion, pea
6	Horti-pastural (HP)	----	Jamun, mango, barseem, jwar, rijka, sugarcane, lucerne
7	Silvi-pastural (SP)	Babul, khejda, siris, ardu	Jwar, barseem, azolla sesbania
8	Apiculture (AP)	Palash, kusum, gulmohar	Mustard, corinander

Dobriyal *et al*., 2019 expressed that the ultimate answer lies outside the forests and especially by the introduction onto peasant farms of agroforestry practices in which trees can be grown for food, fodder and fuel wood, *e.g.* along field boundaries and on unutilized and underutilized corners of farms, home gardens *etc.* The tree component of agroforestry systems can greatly contribute to the restoration of shattered domestic rural economies, becoming a prized capital asset for resource-poor farmers, compensating for seasonal shortages, providing recurrent flows of food, fuel, fodder and other useful materials for rural industries, and conserving soil, water and human energy.

Conclusion

Present study shows that the farmers prominently adopted eight types of agroforestry systems mainly *viz*., Horti-silvicultural (HS), Agri-silvi-horticultural (ASH), Agri-silvicultural (AS), Agri-horticultural (AH), Home-garden (HG), Horti-pastural (HP), Silvi-pastural (SP) and Apiculture (AP) according to household, local needs and livelihood security of this region. The common systems recorded in this region are mandarin+coriander (AH), teak+gram (AS), vegetables+neem+jamun (HG). These Agroforestry practices also provide indirect benefits to the farmers as work soil improver and addition more organic matters to release more nutrients for main crops. Teak or ardu based (boundary

plantation) agroforestry practices are more common in the Hadoti region.

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Corymbia Citriodora- A multi -purpose tree species

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Introduction

Corymbia, sometimes known as bloodwoods, is a type of species closely related to eucalyptus. Ken Hill and Lawrie Johnson defined the genus Corymbia for the first time in 1995. C. gummifera is the type species. Corymbia is derived from the Latin word corymbus, which means "a corymb."

The bloodwoods have been recognised as a distinct group within the wide and diverse Eucalyptus genus since 1867. They, along with the rest of the section Corymbia, are more closely linked to Angophora than to Eucalyptus, according to genetic research undertaken in the 1990s, and the Australian Plant Census now recognises them as a separate genus.

Some popular Corymbia species include: *Corymbia aparrerinja* (Central Australian ghost gum) *Corymbia aspera* (Rough-leafed ghost gum) *Corymbia calophylla* (Marri or Port Gregory gum) *Corymbia citriodora* (Lemon-scented gum) *Corymbia dichromophloia Corymbia eximia* (Yellow bloodwood) *Corymbia ficifolia* (Red flowering gum)

CorymbiaCitriodora

The most important among the corymbia species is *Corymbia Citriodora***.** The trees of this species are medium-sized to large tree that has been widely introduced in tropical and subtropical regions of the world to be used as an ornamental, in reforestation projects, and for production of timber, pulp, and essential oils. It has escaped from cultivation and spread into new habitats, becoming naturalized and invasive in disturbed areas and open forests.

Habitat

C. citriodora grows mainly in warm humid areas and coastal regions with mean maximum temperature of about 30-32°C, mean minimum temperatures of about 9-12°C, and mean annual rainfall of about 650-1600 mm. It is drought tolerant and can grow in areas with a long dry season (i.e., up to 7 months with less than 40 mm/month). ***C. citriodora*** can be found growing on poor, gravelly soils, podsols, residual Podsols, sandy soils, heavy soils, and clay soils (Doran, 1999; Orwa et al., 1999).

Description

Rough, fibrous, or flaky bark, or smooth bark shed in thin flakes or short strips is the characteristics of the Corymbia species. Leaves on juvenile plants and coppice regrowth differ from adult leaves. The phyllotaxy is alternate and the oil glands are common. The flower buds are grouped in groups on a branching peduncle, with each branch normally having seven buds but pedicels of varying lengths, resulting in a flat-topped or convex inflorescence.

Reproductive Biology

The tree C. citriodora is cross-pollinated. It possesses nectar-rich blooms that flies, ants, and, in especially, bees visit and pollinate. When this species is planted outside of its natural range, the frequency of reproduction appears to be affected (Orwa et al., 1999). Flowering has been observed in Australia in January, April-August, October, and December (Slee et al., 2006).

Angophora, Corymbia, and Eucalyptus are all closely related taxa that are collectively known as "eucalypts." Species of *Corymbia* occur in all mainland states of Australia and in the Northern Territory. There are about 100 species, all endemic to Australia except for four species that also occur in New Guinea, and one that is endemic to that country

Risk and Impact Factors

The major impact mechanisms areAllelopathic effect, Competition - monopolizing resources, Competition–smotheringRapid growth

Environmental impact

C. citriodora is an invasive tree that has spread over the world's tropical and subtropical climates (Doran, 1999; Orwa et al., 1999). The allelopathy activity of this species, as well as its delayed decomposition rate, are factors that prevent native plants from germinating, growing, and establishing in invaded areas (Nishimura et al., 1984; Rezende et al., 2001; Evaristo et al., 2011). This plant can also decrease groundwater availability, alter soil nutrients, dispense with native flora, and increase the risk of soil erosion (Schneider, 2003).

Selection for pulp productivity

In the subtropical area of Queensland, Australia, a series of spotted gum (Corymbiacitirodora) progeny studies were created to offer information for the creation of advanced-generation breeding populations appropriate for pulp production.

Although growth was low in comparison to other eucalypts in previous years, near-infrared estimates of average wood density of 756 kg m3 and pulp yield of 55% suggest the species has significant promise as a pulpwood crop.The high wood density and pulp yield of spotted gum species indicates these plantations may also be well suited for pulpwood production (Clark and Hicks 2003, Gardner et al. 2007).Corymbia species, the species' wood density was found to be higher than

the optimal range desired for local pulp mills but quite suitable for a chip export markets (Gardner et al. 2007).

Uses

Utility	Use
Environmental	• Amenity • Land reclamation • Revegetation • Shade and shelter • Windbreak
Fuels	• Biofuels • Charcoal • Fuelwood
Human food and beverage	• Honey/honey flora • Spices and culinary herbs
Medicinal, pharmaceutical	• Source of medicine/pharmaceutical • Traditional/folklore
Wood Products	• Cases • Building poles • Posts • Beams • Bridges • Engineering structures • Flooring • For heavy construction • For light construction • Industrial and domestic woodware • Tool handles

Conclusion

Corymbiacitriodora subsp. variegata is a species with a lot of potential for subtropical locations that have traditionally been regarded problematic for lucrative plantation forestry. Because of the species' capacity to thrive in harsh environments, tolerating endemic pests and diseases, as well as its high wood density and adequate Kraft pulp production, it is a less hazardous and more profitable alternative. The better wood qualities of Corymbia (Gardner et al. 2007) warrant further research by the pulp and paper industry when compared to other eucalypts frequently planted for pulpwood crops. Furthermore, the high quality of the species for solid wood products presents additional value-adding potential and forestry problems.

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Sammi reddy technique of pulpwood yield estimation

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Introduction

To assess the anticipated yield from the Eucalyptus plantations before harvesting, the erstwhile Andhra Pradesh Forest Development Corporation had come up with an idea of estimating the yield of Eucalyptus plantations raised by them prior to the harvesting of plantations in 2004. It's been 18 years for this technique of estimation of yield by measuring representative 100 trees of the plantation. This technique of assessment "100 trees data" was introduced by then Chief General Manager of APFDC Sri. C. Sammi Reddy IFS (1997) hence, they named it as Sammi Reddy method of 100 trees data for this exercise.There had been huge variation in the yield following other techniques which resulted in varied actual yields.

Telangana State Forest Development Corporation Limited

The Telangana State Forest Development Corporation Limited is incorporated on 14.05.2015, under the Companies Act.2013 and also a Trust under the India Income Tax 1961.The organisation is established for raising man-made forests so as to meet the domestic and industrial needs of forest produce and reclothe the degraded forest areas and bring them under productive use.

The objectives of the corporation are as follows:

- ✓ To raise industrial plantations like Eucalyptus, Bamboo etc., to meet the raw material requirement of the wood-based industries in the state.
    - Contributing in protection of the environment and increased forest land productivity.
    - Providing gainful employment to the local tribals and rural people.
    - To provide consultancy in raising plantations of various species.
    - The objectives have been re-defined:
    - Improving the quality and productivity of the degraded forests and plantations.
    - Adoption of Watershed Approach.
    - Adoption of latest gains in Bio-technology for improved productivity.
    - To provide gainful employment to the local people.
    - Capacity building.
    - Implementation of Eco - Tourism Projects.

The plantations raised by the TSFDC are as follows:

a) Eucalyptus
b) Bamboo
c) Cashew nut
d) Teak
e) Sandalwood

Fig. 1 TSFDC Eucalyptus plantation

Methodology

- Prior to the harvesting, the entire plantation has to be enumerated for GBH before 2 to 3 months before the notification of actual harvesting.
- The enumeration register shall be certified and issued by the concerned Divisional Manager for each plantation separately and it should not be changed at all, till final harvesting is completed.
- If the plantation area is up to 30 ha. or where the population is upto 25000, all those trees to be enumerated. If the plantation area is more than 30 ha. or the where the population is more than 25000, alternate rows to be enumerated. The GBH has to be only recorded and heights need not to be taken.

Fig 2. Enumeration for GBH in Eucalyptus plantation

- The enumeration details are to be entered sector wise and girth class wise and it should be test checked by the Regional Manager or Divisional Manager for its accuracy. The girth class wise details of trees and their occurrence are to be posted as indicated into the table below. The following is an illustration of the actual work.

Table 1. Sample table showing no. of trees in each girth class

Sl. N.	Girth Class (cms.)	Avg. Girth of the girth class (cms.)	No. of trees	% of occurrence	No. of trees to be harvested
1.	10-20	15	1878	15	15
2.	21-25	23	1002	8	8
3.	26-30	28	1252	10	10
4.	31-35	33	4382	35	35
5.	36-40	38	1502	12	12
6.	41-45	43	1002	8	8
7.	46-50	48	876	7	7
8.	51-60	55	626	5	5
		Total	**12520**	**100**	**100**

- The representative population of trees in each girth class shall be rounded off to the nearest digit. If the average girth and representative numbers of trees are plotted on a graph, it will show normal distribution curve with most population occupying the centre portion of the bell.
- The % of occurrence is the weighted average of the population of each girth class.
- Now in each plantation, only 100 trees are to be measured of all girth classes. The no. in each girth class should be as per its occurrence (Example: in the above table 31-35 cm girth class has 35% of trees hence 35 trees are selected, covering almost all sector areas and marked).
- The trees so selected are to be banded with red paint or red cloth. These measurements and number of trees shall be test checked by the Regional Manager or Divisional Manager, debarked and stacked. The props and chocks be converted meticulously and the remaining pulpwood and faggot wood shall be stacked. This gives the actual volume of yield derived from 100 numbers of representative trees from the entire population.

Fig. 3 Verification by the Divisional manager

- The selected 100 trees are harvested and debarked on same day of the exercise and the stem was cut into 2mts. billets. The billets of each girth class are weighed twice, once on the day of harvesting and the next on the following day.

Fig 4. Harvesting of selected trees

- The fresh weight and dry weight of the stems were used to estimate the yield of pulpwood in the respective plantation.

Fig. 5 Weighment of billets for the fresh weight and Dry weight

- The estimated yield for the entire plantation can be computed by using the following formula
  Formula: **A x Total number of trees / 100 (in cmt.),** where A is the volume of yield obtained from 100 trees.
- The volume of yield is to be computed separately for pulpwood and faggot wood in cubic meters and for chocks and props it shall be in numbers.

Fig 5. Stacking of billets of pulpwood for volume estimation

- The yield is expected that by adopting the above method, the

variation between the estimated yield and actual yield may not be more than 5%.

Conclusion

This method along with supply of pulp wood within 24 hours has changed the fortunes of TSFDC and APFDC from 2004 which was hither to running on thread bare margins. Prior to 2004 Eucalyptus pulpwood estimation used to be done by laying sample plots taking 10% enumeration for GBH and 5% for height measurement respectively. There used to a lot of variation and bias, sometimes leading to gross under estimation of yield also. By taking trees from all girth class as per the representation population the anticipated yield is estimated near to accuracy with meagre 2-3% of deviation.

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Degradation of primary natural habitats and avian biodiversity loss

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Annual Review of Environment and Resources recently published the State of the World's Birds Report 2021 that exposed unsettling scientific revelations on the perilous state of global avian diversity. The study (Lees et al. 2022) suspects approximately 48% of the 10,994 surviving species of birds to show declining trend of population.

Global Scenario

Reviewing the structural changes in avian biodiversity using the data retrieved from International Union for Conservation of Nature and Natural Resource's Red List, the report has cited 39% of species as showing signs to stable population, 7% with increasing population trend while population status of 37 species were unknown. The main reason attributed to the rampant decline in the population status of at least 50% of the species (half of the known 10,994 surviving species of birds) is anthropogenic intrusion. Expanding human footprint and over exploitation has indiscriminately resulted in wanton destruction of their habitat, foraging sources and reproductive behavior.

Indian Scenario

India joins the League of Nations where the state of avian diversity is alarmingly declining. Out of the 146 species whose annual growth trends for the past five years have been assessed, nearly 80% of them showed negative growth trend, 50% of which slumped precariously. The proportion of species studied, showing stable population inched just over 6%, while only 14% were found to have increasing population trends. Among the most threatened birds included endemic species, birds of prey and species that inhabit forests and grasslands.

According to the Visionary Perspective Plan (VPP) 2020-2030 drafted by the Ministry of Environment, Forest and Climate Change (MOEFCC 2019), there are 1,317 bird species in India. Out of these, 72 are endemic, 17 are critically endangered, 20 are endangered, 100 are threatened and 63 of them classified as vulnerable. The plan listed poaching, fragmentation of ecosystem, habitat loss and epidemics as the prime reasons for their endangerment. The draft also cites that 2,01,503 wetlands spread across 2.25 hectares in India are under varying grades of ecological stress, which has both direct and indirect implications on the incessant loss of Indian avifauna.

Another first-of-its-kind analysis report entitled "State of India's Bird 2020" released at the 13th Conference of Parties of the Convention on the Conservation of Migratory Species of Wild Animals held at Gandhinagar, Gujarat exposed

several threats to the extant bird species of the country. The report utilised citizen science database with over 10 million observations to assess the status and distribution of common Indian birds. The report categorised specific migratory shorebirds, raptors, habitat specialists such as Pacific Golden Plover, Curlew Sandpiper, Richard's Pipit, Large-billed Leaf Warbler and birds of prey such as White-rumped Vulture and Indian Vulture in groups that exhibited greatest declining trends of population. Feral Pigeon, Glossy Ibis, Rosy Starling, Plain Prinia and the Ashy Prinia were among the few species figured in groups that showed an increasing trend of population.

Species wise Analysis

Indian Peacock

The population of India's National Bird has increased considerably over the past few decades. Listed as Least Concern on the IUCN Red List, Indian peafowls have broadened the range of their habitat, migrating *en masse* to human settlements in both urban and rural India. The bird has also expanded its range to areas where it was previously absent or negligible in population such as Kerala. Scientists also suggest that such dramatic increase in range and population of peafowl pose serious threat to the food basket of the state as they are known to feed voraciously on agricultural crops. Conservationists also see the species as potential harbinger of drought in those states of its range expansion. Increase in its population is attributed to the conservation efforts and penalties imposed under the Schedule 1 of Wildlife (Protection) Act 1972.

Indian Bustards

India is home to four species of Bustards namely the Great Indian Bustard, Macqueen's Bustard, Lesser Florican and Bengal Florican. IUCN Red List has listed the Great Indian Bustard, Lesser Florican and Bengal Florican as Critically Endangered (CR) and Macqueen's Bustard as Vulnerable (VU). The Great Indian Bustard, once a contender for the title of "India's National Bird" is a flagship grassland species whose population is mostly confined to the states of Gujarat and Rajasthan. Frequent victims to electrocution with power transmission lines in their foraging habitats; hunting (still prevalent in Pakistan), slow reproductive rate, rampant destruction and diversion of grasslands are the most probable reasons responsible for their decline. Even though the species is kept under the Species Recovery Programme under the Integrated Development of Wildlife Habitats of the Ministry of Environment, Forests and Climate Change (MoEF&CC) and a Conservation breeding facility has been established by MoEF&CC and Wildlife Institute of India at Desert National Park at Jaisalmer in 2019, their population is due to demonstrate encouraging signs of growth.

Indian Vultures

India hosts nine of the global vulture species with majority of them facing imminent threat of extinction.

Sl. No.	Common Name	Scientific Name	IUCN Red List Status
1.	White-backed Vulture	Gyps bengalensis	Critically Endangered
2.	Long-billed Vulture / Indian Vulture	Gyps indicus	Critically Endangered
3.	Slender-billed Vulture	Gyps tenuirostris	Critically Endangered
4.	Red Headed Vulture/ Asian King Vulture /Pondicherry Vulture	Sacrogypscalvus	Critically Endangered
5.	Egyptian Vulture	Neophron percnopterus	Endangered
6.	Himalayan Griffon Vulture	Gyps himalayensis	Near Threatened
7.	Cinereous Vulture	Aegypiusmonachus	Near Threatened
8.	Bearded Vulture	Gypaetus barbatus	Near Threatened
9.	Indian Griffon Vulture	Gyps fulvus	Least Concern

Population of vultures plummeted drastically during the early 1990s. Their decline is primarily ascribed to inadvertent poisoning by a Non Steroidal Anti-Inflammatory Drug (NSAID) administered to livestock called diclofenac.The Government of India banned the use of diclofenac for livestock since 2006 and introduced alternative drugs such as aceclofenac, ketoprofen and nimesulide for veterinary use. But latest researches in the domain establish the three NSAIDs (aceclofenac, ketoprofen and nimesulide) as potential drivers of decline in vulture population similar to diclofenac. The Bombay Natural History Society (BNHS) has also written to MoEF&CC to impose a ban on the other three NSAIDS as it threats to overturn decades long conservation efforts to revive the dwindling population of vultures in India. Madras High Court in one of its verdict recognised Vultures as "Natural Sanitary Workers" instead of natural scavengers and stated that conservation of vultures to preserve ecological balance is non-negotiable. India's Vulture Conservation Action Plan for 2020-2025 will serve the cause, only if its recommendations can be strengthened through statutory orders for compliance.

Water birds or wetland birds

Different species of water birds showed long term declines in their

population, habitat and breeding behavior. State of India's Bird 2020 report identifies migratory shorebirds, gulls and terns as species showing precipitous plunge in growth trends. Draining of wetlands, conversion, illegal encroachment and exploitative agriculture are the prime reasons responsible for their decline.

House Sparrow

The State Bird of Delhi has been found to be stable across the country but declining in urban metropolitan cities. Development of urban heat islands in metro cities, non availability of feeding stock (insects) in urban landscapes, paucity of nesting and brooding cites and pollution are cited as major reasons of their shift in population.

Important threats

There are eight factors which are reportedly contributing to the global avian biodiversity loss namely: (i) Land-Cover and Land-Use Change, (ii) Habitat Fragmentation and Degradation, (iii) Hunting and Trapping, (iv) The Impact of Invasive Alien Species and Disease, (v) Infrastructure, Energy Demands, and Pollution, (vi) Agrochemical and Pharmaceutical Usage, (vii) Climate Change and (viii) Global Trade Teleconnections. Growth of human populations and of per-capita rates of consumption has been found to have directly impacted conversion and degradation of primary natural habitats and consequent loss of biodiversity. Ongoing loss of habitatthrough the twentieth and twenty-first centuries is now causing threat to more species, with 1,213 globally threatened species impacted by ecosystem conversion, including 165 Critically Endangeredspecies directly threatened by land-use change, and several recent extinctions driven by habitatloss.

Anthropogenic habitat fragmentation has long been understood to be a major driver of species loss, especially in the tropics.Species with low dispersal capacity may become isolated in habitat patches too small or too degraded by associated edge effects to meet their needs, making local extinction more likely. Species-area-isolation relationships are one of the strongest ecological principles; therefore fragmentation effects remain a major threat to avian biodiversity, especially in the tropics.

Approaches to reverse the decline

Efforts to stem the tide of avian extinctions and loss of wider abundance through the twentyfirst century require a substantial expansion of existing efforts, as well as a focus on new ones and a solid knowledge base of threats to individual species and their severity. Measures to revive the avian biodiversity should also be revisited global, national and regional priorities using meticulous assessments and providing species specific conservation breeding programmes.

Key actions require including effective conservation of the most important sites, mitigation of key direct threats,broader-scale policy responses, and targeted species-recovery programmes for those species for which threatmitigation and site/habitat conservation are insufficient. Ensuring financial assistance in the form of grants-in-aid to citizen scientists, researches, NGOs should also go hand in hand with timely recognition of research findings, actions (legal and executive) to serve the cause, adequately backed by penal provisions to bring violators and defaulters under the radar of law.Valuing primary habitats, either through Reducing Emissions from Deforestation and Forest Degradation (REDD+) schemes, which create a financial value for the carbon stored in forests, or via best-practice resource management such as low-intensity logging, are likely to be key pathways to maintain and expand these habitats.

Climate change has also been an important emerging driver of change in bird communities and is a particular concern for tropical montane, polar, and migratory species. But at the same time initiatives like Green energy transitions are essential to limit dangerous climate change but it can have negative impacts on birds if inappropriately implemented.

Alongside all of these approaches, any visible change in the reversing the decline can only happen if the science, citizen, governments and human society at large shifts to an economically sustainable development path.

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Light trap: An eco-friendly tool of integrated pest management

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Introduction

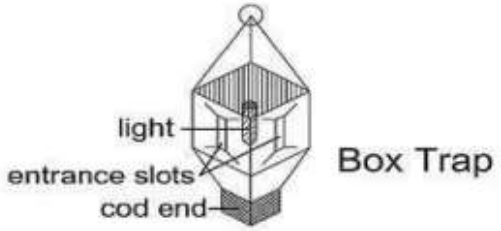
Integrated pest management (IPM) uses a range of preventive measures to control insect pests and significantly reduces the need to use chemicals while providing protection, probably at a better level. Frequent and reliable monitoring of pest populations is one of the most critical components of integrated pest management (IPM) program. One of such tools of IPM is the use of physical traps which are employed in place of synthetic pesticides. Insect traps are either used to monitor and or to directly reduce populations of insect pests. Visual lures use light, colours and shapes to attract pests. The ability to attract specific insect species to the traps depends on the type of trapping equipment. Placement of traps is essentialthey must be placed in such a manner that pests, if present, are likely to come into contact with them. Equally essential are an adequate number of traps for effective monitoring (Tea research association). Development of non-chemical, eco-friendly methods of pest control-as a component of IPM tactics is a priority area of research today. With the reported development of multiple resistances in larval stages against recommended insecticides, spoiling of crop ecosystems with toxic chemicals and consequent health hazards, the best alternatives are to control the pest in adult stage before they reproduce. Use of light traps is one of such potential methods of control against the species known to be positively phototropic behaviour in adult stage.

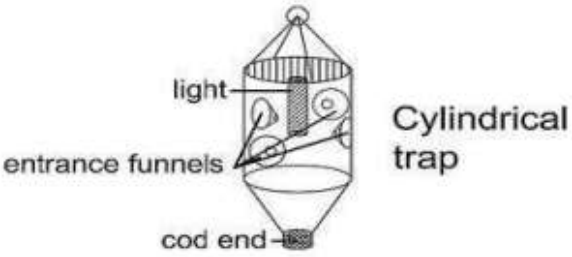
Use of light trap in combination with pheromone traps is a part of "Adult oriented strategy of IPM" recently proposed and discussed by Vaishampayan (2002). Many of the insect species, mostly nocturnal, are known to be positively phototropic and attracted towards artificial light in large numbers. Entomologists have used this phenomenon since long to capture night flying insects in a device called light trap. Gardeners may utilize this phenomenon to capture night flying insects (looper moths, red slug moths, green hoppers etc.) by this device. While insects are attracted in a lesser degree to open fire, oil lamps, paraffin lamps, kerosene lamps and other light sources, the most effective lamps are those with a high emittance in the UV part of the spectrum (350 nm to 550 nm). The lamps which normally come within this range of spectrum are Actinic BL light, mercury vapour lamps, black light lamps and fluorescent tubes.

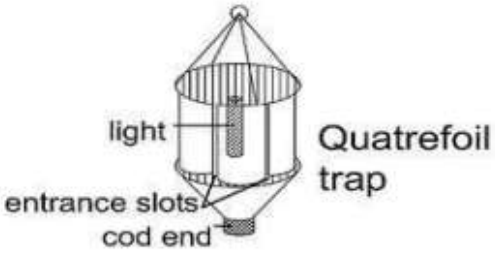
Types of light traps

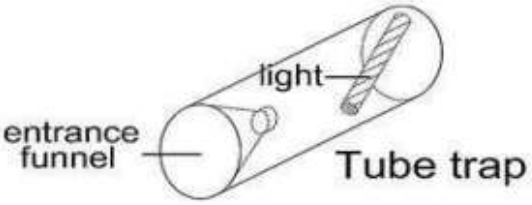
There are two types of insect light traps viz., box type and funnel type. An outer wall containing a light source consists of two panes of glass sloping to a narrow horizontal aperture in case of box type traps. As the insect enters into chamber, there is little opportunity to escape. In case

of funnel shaped trap, a light source is suspended over a funnel which tappers into a chamber beneath it. As the insect enters into the chamber through funnel, it cannot escape. Funnel shaped trap was initially devised for the collection of moths but its use is common for insect collection now a days. Recently various types of light traps are developed for insect catch and monitoring. There some important light traps used in agricultural ecosystems are mentioned below;



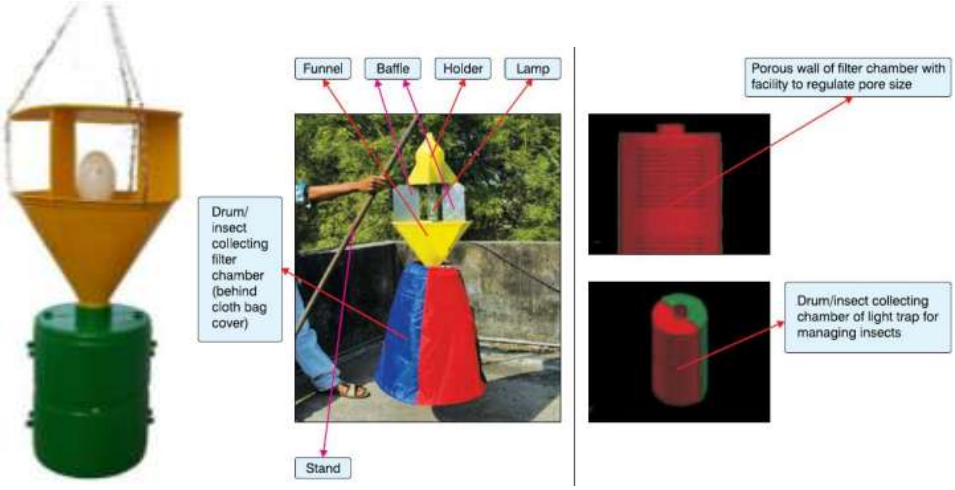






NCIPM Light Trap

National Centre for Integrated Pest Management (NCIPM), ICAR, New Delhi has developed an aerial insect trap, which can be used to monitor the population of airborne or flying insects in the field; more particularly it is used to monitor the populations of insect pests and their insect natural enemies in agro-ecosystems. This device for beneficial insects has been designed for conservation and enhancement of the population of beneficial insects i.e., larval parasitoid wasps in the crop fields. It is an important tool of IPM and provides sustainable pest control. The precise advantages of this aerial-insect trap are:



a. This trap can be used for quantitative and qualitative estimation of flying insects in the field.

b. Since there is no kind of lure in the trap, the collection will represent the unbiased natural population of insects in the area where it is used.
c. Observations can be made at any time interval with any frequency as per requirement or convenience.
d. The trap catches both harmful (pests) and useful insects (parasites and predators) in the field. The insect collector is designed in such a way (small perforation on the wall) that small parasites and predators can escape form the trap.
e. Use one trap per hectare.

SPECTRUM Insect Flasher

Insect Flasher is a flying insect flashing system. This uses corrosion-resistant aluminium casting in the fabrication of Insect Flasher and is 100% powder coated. The lamps used in SPECTRUM Insect Flashers, radiate primarily between 350-400 nm, and the UV output is approximately 2.8W and the entire energy is being utilized for insect trapping. The transformers & capacitor circuitry are heavy duty type and are designed for continuous operation. The transformer circuit is optimally matched with the power grid, and hence flashing is instantaneous. We can use one trap per hectare.

TRA fabricated Light Traps

The Tea Research Association (TTRI, Jorhat) has fabricated a few low-cost light traps specifically meant for tea plantations. Since electricity is a major issue in tea plantations, these traps have been developed for use with rechargeable batteries. Where electricity is not available one can use 1 KW portable genset for using a set of 50 actinic lights. When electricity is not available ordinary

petromax lamps can also be used in light traps.

TRA low cost CFL light trap

Light sources and wavelength of light used in light traps

Light traps utilizing electric lamps as the attractants can be classified into three groups viz. Electric grid, Suction or fan type and Mechanical or gravity trap. The first and second type requires 110 V electric supplies while the third type operated directly at 110 V. However, very few are powered by dry cells or storage batteries. Insect species differ in the attractiveness and depends upon the specific wave length of light. The ultraviolet and mercury light attracts the pink bollworm moth. Certain insects extend the range of responses into the UV region or more precisely below 300 nm. However, many insects show peak response in the UV region at about 365 nm. Other insects show a peak response in the range between 490 to 520 nm. The range of wavelength of light is the major factor of attraction of insects towards the light.

Type of light sources, which can be used in light trap where electricity is available:

1. Incandescent Tungsten filament lamp 100 to 150 watts.
2. Latest Energy saver, compact fluorescent lamp (FL).
3. High Intensity discharge Lamps M.V. lamps and sodium lamps.
4. Black light or ultra violet lamps 15 to 20-watt UV lamps.
5. Mercury vapour (M.V.) lamps 80 watt, 125 watt and 160 watt, emitting energy in all the wavelength bands covering insects vision spectrum ranging from 350 to 700 nm, followed by 15 watt Ultra Violet (U.V.) TL lamps are the best light sources for attracting majority of noxious insect pest species including Lepidopteron and Coleopteron insects. Incandescent bulbs emitting yellow radiation are a poor source for noctuid but a good source for leafhoppers, gall midges and paddy hoppers/bugs.

Where regular electric supply is not available electric lamps can used with

1. Portable generators (Diesel/ Petrol operated)

2. Solar photovoltaic generators
3. Non-Electrical sources
4. Light trap can be operated using following non-electrical sources producing visible light:
    5. Kerosene lamps/Petromax
    6. LPG gas lamps
    7. Carbide (Acetylene) gas lamps
    8. Oil torches using waste mobile oil

Factors affecting light trap catches

Total species richness and abundance of trapped moths may be influenced by several factors such as night temperature, humidity and lamp type. For field work, however, the choice of lamp type is more often determined by the actual field conditions than purely by scientific considerations. If there is access to electricity or if a portable generator is available, mercury vapour lamps, black-light lamps or Actinic BL light lamps are the best choice because their emittance in the UV range is higher than that of standard household light bulbs (tungsten bulbs).

Success of light trap as IPM tool depends solely upon its trapping efficiency and retention of collected specimen in good condition. Design of light trap and light source used are important factors. If trapping is insufficient it would aggravate the problem by inviting more adults in the trap area. Weather extremes and bright moon light adversely affect the size of the trap catch. The size of a total catch in light trap or net trapping efficiency (numbers trapped/total present) is determined by three principal factors viz.

1. Number of adults (population) actually present in the environment in the trap area.
2. Behavioural response of insects towards light source influenced by:
    a. Type of flight movement
    b. Bright moon light
    c. Design of trap used and light source used (spectral quality)

Conclusion

Light trapping systems for insects are important components in integrated pest management programs. Light trap sampling is commonly used in insect biodiversity studies. A wide variety of light traps with different light designs are being used. Numerous light sources have been used to access the photo response of the different insect species since last forty years. However, not all the light sources proved efficient to attract and collect all the nocturnal insect species insects in a particular habitat. The success of light traps is affected by a wide variety of factors like environmental conditions, trap design, height of the light source, attraction radius of a light source, surrounding anthropogenic lights, wave length, intensity of light source, timing and duration of light trap, all of these affects the success of light trap. These traps became important tools to the entomologist community to assess the seasonal abundance and the time of appearance of important insect pest species.

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Vanya silk: An exclusive non- timber forest produce

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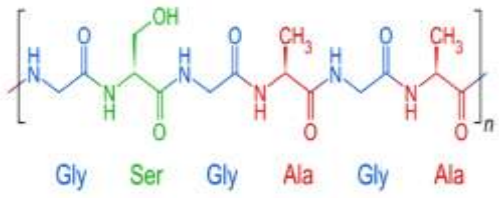
Silk emitted by the silkworm consists of two main proteins, sericin and fibroin, fibroin is structural centre of the silk, and serecinis the sticky material surrounding it. Fibroin is largely made up of the amino acids Gly-Ser-Gly-Ala-Gly-Ala and forms beta pleated sheets, β-keratin (Fraser and Mac, 1973).



Structure of Fibroin

India produces four kinds of silk viz. mulberry, tasar, muga and eri. It is broadly classified into two distinct sectors viz., mulberry and non-mulberry. Mulberry silkworm (*Bombyx mori*) feedson mulberry plants (*Morus indica*) wild or cultivated, in all over India which produce shiny creamy white colour silk.

Non-mulberry silk is known as **forest or "Vanya" Silk**, abundantly found in remote regions, hilltops and in forest interiors of India. Vanya Silk includes Tasar, Eri and Muga silks (Jayprakash, 2011).

Process of silk cultivation/ production

Host plants

Silkworm feed on host plant leave

Cultivation of Silkworm

(The silkworm is the caterpillar of a small half moths belonging to "bombyx" which lives only on leaves of mulberry tree.)

Mounting

(After 35 days of hatching worm is 10000 times as heavy as it was born and it has become greenish white cater pillar. Now it is ready to start spinning, silk worm built its cocoon to settle down in it).

Silk worm spin silk and formation of cocoon

(The liquid silk comes from two glands called spinneret in the silkworm head, as the liquid comes out it is hardened into very fine filaments which are coated by a gummy substance called sericin which comes from other two glands nearly.)

Reeling the filament and spinning to get raw silk

(The process of unwinding the filament from cocoon is called reeling.)

(The cocoons are put through a series of hot and cold immersions, as the sericin must be softened to permit the unwinding the filament as one continuous filament).

Twisting and degumming of rawsilk

The silk worm *(Anthereapaphia*) found in the wild on forest trees (*Anogeisus latifolia, Terminalia tomentosa, Terminalia arjuna, Lagerstroemia parviflora and Madhuca indica*) produces the famous "Tasar" silk of India.

The Eri silk worm (*Samiaricini*) feeds on castor (*Ricinuscommunis*) and kesseru (*Heteropanaxfragrans*) in Assam and Eastern part of India, produce dull white colour silk.

Muga silk worm (*Antheraeaassama*) feeds on som (*Machilusbombycina*) and soalu (*Litsaeapolyantha*) in Bramhaputra valley and produce light yellow colour silk. Other wild silk worms are *Antheraeaassamansis*, producing "Muga" silk and *Philosamiaricini* producing "Eri" silk.

Temperate tasar silk worm (*Antheraeamylitta*) that feeds on Quercusspp, produce copper brown colour silk and tropical tasar worm (*Antheraeaproylei*) feeds on Ber (*Ziziphus mauritiana*), Dhawa (*Anogeissus latifolia*), Baheda (*Terminalia bellirica*) and Jamun (*Syzygium cumini*) in Bihar, Jharkhand to Karnataka imparting copper/yellowish brown colour silk (Chatterjee and Chakravorty, 2009).

India is the only country producing all the three “Vanya” silks commercially exploited the mulberry silk.

Muga silk, the golden silk of Assam is the exclusive product of India.

India is the second largest producer of silk in the world and the total raw silk production in the country increased by 10.52 per cent during 2018-19 over the previous year.

Sericulture involves low investment with frequent income with 5-6 crops per annum for 15-20 years. Among the four varieties of silk produced in 2018-19, mulberry accounts for 71.50 per cent (25,213 MT), Tassar 8.44 per cent (2977 MT) Eri 19.40 percent (6839MT) and Munga 0.66 percent (232 MT) of the provisional total raw silk product (Dewangana et.al., 2011).

Mulberry silkwormcocoons (*Bombyxmori*)

Temperate tasarcocoons (*Antheraeamylitta*)

Tropical tasarcocoons (*Antheraeaproylei*)

Muga silk worm cocoons (*Antheraeaassama*)

Eri silk worm cocoons (*Samiaricini*)

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Larval parasitoids, *Apanteles* species as insect biocontrol agents

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Abstract

Biological control of insects is widely accepted, ecologically safe and non toxic tool for management of forest insect pests. Larval parasitoids play an important role in minimizing insect populations in nature. In forestry, larval parasitoids belonging to the genus, *Apanteles* Foerster (Hymenoptera: Braconidae) have been recorded on a large number of lepidopteran caterpillars. The present article has critically reviewed these aspects with special reference to *Apanteles* species parasitizing major insect pests of forestry.

Key words: *Apanteles* species, larval parasitoids, biocontrol agents, forestry.

Introduction

Integrated Insect Pest Management (IIPM) is widely accepted for the management of insect pests with biological control as one of the vital component. During the last 30 years, Hymenopteran parasitoids have been widely utilized in biological control of insect pests all over the world. Species belonging to the genera *Apanteles*, *Bracon*, *Chelonus* and *Trichogramma*, are credited with several successful stories of biological control of key insect pests all over the world (Debach and Rosen, 1991). Several exotic Hymenopteran parasitoids were introduced for biological control of Lepidopteran insect pests of agricultural, commercial, horticultural and forestry crops in India.

The parasitic wasps, *Apanteles* species are important larval parasitoids of several lepidopterous pests of agricultural crops, commercial cash crops and forest tree species. Adult wasps are free-living and females insert their eggs beneath the skin of the host larvae, where eggs hatch and their young ones feed. Finally, mature larvae leave the hosts and spin cocoons before larval-pupal transformation. After pupal-adult transformation wasps emerge from the cocoons. *Apanteles* Foerster belongs to the order Hymenoptera, family Braconidae and sub-family Microgastrinae. It is the most conspicuous single group of endo-parasitoids of Lepidoptera in the world, both in terms of species richness and economic importance. In India, considerable work has been carried out on identification of *Apanteles* species only (Wilkinson, 1928a, b). Several *Apanteles* species have been recovered from a large number of native Lepidoptera and are potential biocontrol agents to check the population of important insect pests (Chatterjee and Misra, 1974).

The genus, *Apanteles* belongs to the Family Braconidae, which was erected by Stephens (1829). Torre (1898) has compiled the world list of Braconidae. Szepligeti (1904) has divided Braconidae into 31 subfamilies. Wilkinson (1928a, b) has revised Indo-Australian *Apanteles* species and also revised Indo-Australian

and Ethiopian species of *Microgaster* (Wilkinson, 1929). Achterberg (1976) has discussed evolutionary trends and systematic position of Braconidae. Mason (1981) has reclassified Microgastrinae and discussed polyphylatic nature of *Apanteles.* Quicke (1987) has provided a key to old world genera of Braconidae. Achterberg (1984, 1988), Quicke and Achterberg (1990), Achterberg et al. (1992) and Whitfield and Manson (1994) have given phylogeny of Braconidae. Sharkey (1993) has divided Braconidae into 29 subfamilies. Then, Achterberg (1993) has divided Braconidae into 47 subfamilies. Wharton et al. (1997) has recognized 34 subfamilies under Braconidae from new world. Wharton and Achterberg (2000) have recognized Braconidae as a very large family comprising about 15,000 species and cosmopolitan in distribution.

Braconids are important egg-larval and larval-pupal parasitoids of insect pests of agricultural crops, horticulture and forest tree species. The final instar larvae of braconids consume almost the entire host, except skin and head capsule (Boodryk, 1969). Details on Braconid's biology, has been provided by Shaw and Huddleston (1991) and Wharton (1993).

Identification of *Apanteles* species

The genus *Apanteles* was erected by Foerster (1862) and since then the *Apanteles* species have been studied by several researchers (Wilkinson, 1928a, b; Nixon, 1967; Mason, 1981; Papp, 1987; Whitefield, 1997). In India, considerable work has been carried out mainly on identification of *Apanteles* species (Rao, 1961; Sharma, 1972, 1973; Sathe and Inamdar, 1989; Sumodan and Sevichan, 1989; Sumodan and Narendran, 1990, Sathe and Ingawale, 1995; Kurhade and Nikam, 1997; Roychoudhury, 2013).

***Apanteles* species as larval parasitoids of lepidopteran insect pests**

Several workers (Beeson, 1941; Chatterjee and Misra, 1974; Varadarasan, 1985; Ghosh and Abdurahiman, 1988; Mohan et al., 1992; Bai and Marimadaiah, 2000; Pandey et al., 2004; Roychoudhury, 2013) have recovered *Apanteles* species from native lepidopteran pests, which are undoubtedly important for controlling the population of important insect pests.

***Apanteles* species as biocontrol agents**

The *Apanteles* species form an important parasitoid complex of many key lepidopterous insect pests and are frequently featured in biocontrol programmes. *Apanteles glomeratus* was the first parasitoid which was imported into North America from Europe, in 1883 for the control of common cabbage butterfly, *Pieris rapae*. Several important species from India including *A. flavipes* have been reported to cause about 56-90% parasitism on larvae of *Chilo partellus*. The same species had also been sent to Barbados in 1967 from India for the control of sugarcane borer, *Diatraea saccharalis*, where the parasitoid has been reported to have resulted in excellent and economic control of the pest. Parker (1951) has utilized *A. rubecula* for controlling the serious cabbage worm, *Pieris rapae* in Missouri (Debach and Rosen, 1991).Walker and Welter (2004) examined the potential of *A. aristoteliae* in suppressing *Argyrotaenia citrana* in apple orchards of California. Patel and Patel (1991) have taken the field observations on *A. ruficrus*, larval parasitoid of army

worm *Mythimna separata*. Nigam (1984) has reported field parasitization of *A. ruficrus* on *Chilo auricilius*. Krishnamoorthy and Mani (1985) have evaluated the potential of exotic parasitoid *A. marginiventris* against *Spodoptera litura*, under field cage conditions. *A. angaleti* has been reported as an important parasitoid of pink boll worm, *Pectinophora gossypiella* of cotton, only larval parasitoid active throughout crop season in Punjab (Singh et al., 1988).

In forestry, Beeson (1941) mentioned that during the year 1937-1938, *A. hyblaeae* (Fig. 1) and *A. malevolus* have imported from Myanmar, only *A. malevolus*, has been released at Nilambur teak forests for management of *Hyblaea puera*. Beeson (1941) was the first to mention about the biology of *Apanteles* species. He recorded 25 species of *Apanteles* from India as parasitising various insect pests. *A. puera* and *A. malevolus* on *H. puera* and *A. machaeralis* (Fig. 2) and *A. ruidus* on *Eutectona machaeralis* have been recorded from teak forests (Beeson, 1941). Chatterjee and Misra (1974) enlisted 49 species of *Apanteles* from India, out of which four species of *Apanteles*, viz. *A. malevolus* and *A. puera* are reported to parasitise the larvae of *H. puera*, and *A. machaeralis* and *A. ruidus* parasitise the larvae of *E. machaeralis*. Till date 85 species of *Apanteles* infesting various insect pests have been recorded from India. Nair et al. (1995) have recorded *A. hyblaeae*, *A. machaeralis*, *A. malevolus* and *A. puera*, as parasitoids of teak defoliator *H. puera*. Roychoudhury (2010, 2016) has recorded that *A. machaeralis* is a major larval-pupal parasitoid of *E. machaeralis* in teak forests of Madhya Pradesh. Roychoudhury (2013) has also recorded 30 species of *Apanteles* on major defoliators of teak and nine species on major defoliators of sal in Odisha (Roychoudhury et al., 2020). Recently, Roychoudhury et al. (2022) have published detailed biology of *A. machaeralis* on *E. machaeralis*. Excepting this, nothing is known about various species of the genus *Apanteles* parasitizing the major insect pests of forestry.

Fig. 1 : *Apanteles hyblaeae*

Fig. 2 : *Apanteles machaeralis*

Conclusively, it is clear from the foregoing account that in order to develop an applied biological control method of key insect pests of important tree species, it is imperative to work on promising species of *Apanteles*, their biology, parasitization potential, laboratory evaluation and field efficacy.

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